

## **System for Precise Position Registration**

- 1) The United States of America may have certain rights to this invention under  
5 Management and Operating contract No. DE-AC05-84ER 40150 from the  
Department of Energy.

### **Field of the Invention**

- 10 2) The present invention relates to a system for retaining precise positions on a  
broad-area surface after non-*in situ* processing and more particularly to a system to  
improve position retaining on high resolution instruments which are located in  
inaccessible areas, such as in a vacuum chamber.

### **Background of the Invention**

- 15 3) It is often necessary to examine samples within environments that are  
difficult to access, such as within a vacuum chamber. Instruments such as electron  
microscopes and high-resolution optical microscopes are often used to examine the  
20 samples. After an interesting spot worthy of examination is located, it is often  
necessary to reacquire the spot at a later time. Precise position retaining is therefore  
required for relocation of a small interesting spot or feature after non-*in situ*

processing of a sample. Current state of the art equipment for reacquiring  
microscopic positions is usually complex mechanically, and therefore difficult to  
maintain and prone to frequent maintenance. What is needed is a precise position  
registration system that is simple mechanically and that provides good accuracy in  
5 x, y repeatability.

### Summary of the Invention

4) The present invention describes an apparatus for enabling accurate retaining  
10 of a precise position, such as for reacquisition of a microscopic spot or feature  
having a size of 0.1 mm or less, on broad-area surfaces after non-*in situ* processing.  
The apparatus includes a sample and sample holder. The sample holder includes a  
base and three support posts. Two of the support posts interact with a cylindrical  
hole and a U-groove in the sample to establish location of one point on the sample  
15 and a line through the sample. Simultaneous contact of the third support post with  
the surface of the sample defines a plane through the sample. All points of the  
sample are therefore uniquely defined by the sample and sample holder. The  
position registration system of the current invention provides accuracy, as measured  
in x, y repeatability, of at least 140  $\mu\text{m}$ .

20

## Description of the Drawings

5) Fig. 1 is a top view of a system for precise position registration according to the present invention, including a sample and sample holder.

5

6) Fig. 2 is a sectional view of the sample and sample holder taken along line 2-2 of Fig. 1.

7) Fig. 3 is a sectional view of the sample and sample holder taken along line 3-3 of Fig. 1.

10

8) Fig. 4 is a bottom view of a sample in accordance with the present invention.

9) Fig. 5 is a top view of a sample holder in accordance with the present

15 invention.

## Reference Numerals Used in the Specification and Drawings

10 – system for precise position registration

20

12 – sample

14 – sample holder

16 – sample body

18 – top side of sample

20 – bottom side of sample

25

22 – cylindrical depression

24 – U-groove depression

26 – base of sample holder

28 – first support post

- 30 – second support post
- 32 – first conical tip
- 34 – second conical tip
- 36 – third support post
- 5 38 – hemispherical tip
- 40 – side wall of cylindrical depression
- 42 – inner surface of cylindrical depression
- 44 – short side walls of U-groove depression
- 46 – long side walls of U-groove depression
- 10 48 – inner surface of U-groove depression
- 50 – outer surface of first conical tip
- 52 – outer surface of second conical tip
- 54 – lower edge of side wall
- 58 – point
- 15 60 – lower edge of long side wall
- 62 – line through sample
- 64 – plane through sample
- 66 – offset

20

### **Detailed Description**

10) A top view is shown in Fig. 1 of a system for precise position registration 10 according to the present invention. The system includes a sample 12 and sample  
25 holder 14.

11) Referring to the cross-sectional view of Fig. 2, the sample 12 includes a body 16 having a top 18 and a bottom 20 side. The bottom side 20 of the sample 12 includes a cylindrical depression 22 and a U-groove depression 24. The sample  
30 holder 14 includes a base 26 having a first 28 and second 30 support post. The first support post 28 includes a first conical tip 32 and the second support post 30 includes a second conical tip 34.

12) With reference to Fig. 3, the sample holder 14 also includes a third support post 36 having a hemispherical tip 38.

5 13) Referring now to Fig. 4, the bottom side 20 of the sample 12 includes the U-groove depression 24 and the cylindrical depression 22. Although the sample 12 is depicted as being round, it should be understood that the sample could be square, rectangular, polygonal, or virtually any shape. The cylindrical depression 22 includes a side wall 40 and an inner surface 42. The U-groove depression 24 includes  
10 short side walls 44 and long side walls 46 and an inner surface 48.

14) With reference to Fig. 5, the sample holder 14 includes three support posts including a first 28, second 30, and third 36 support post. The first 28 and second 30 support posts are depicted with first 32 and second 34 conical tips thereon,  
15 respectively. The third support post 36 includes the hemispherical tip 38, and therefore is depicted in Fig. 5 without a sharpened tip. Superimposed on the sample holder 14 of Fig. 5 in phantom lines are the relative locations of the cylindrical depression 22 and U-groove depression 24 of the sample (not shown), as they will rest after being placed on the sample holder 14. The relative locations of the  
20 cylindrical depression and U-groove depression will be explained herein in the description of the operation of the present invention.

15) As shown in Figs. 2 and 5, the first 32 and second 34 conical tips include outer surfaces 50 and 52, respectively, as shown. The outer surfaces 50, 52 of the conical tips 32, 34 are sloped away from the conical tips 32, 34 in all directions.

5 16) For an understanding of the operation of the system for precise position registration according to the present invention, reference should be made to Figs. 1-5. A sample holder 14 is provided having three support posts, including a first 28 and second 30 support post having conical tips 32, 34 respectively, as shown in Figs. 2 and 5. The sample holder 14 is also provided with a third support post 36 having a  
10 hemispherical tip 38 as depicted in Figs. 3 and 5. The purpose of the sample holder 14 is to establish a precise position registration system for the sample 12. The bottom side 20 of the sample 12 is provided with a cylindrical depression 22 and a U-groove depression 24. The sample holder 14 can then be placed within a vacuum chamber (not shown) or other closed inspection area. The sample holder 14 can be  
15 locked in place by clamps, two-sided tape, or similar fastening means (not shown). The sample 12 is then placed upon the sample holder 14 in such a manner that the first conical tip 32 of the first support post 28 enters the cylindrical depression 22, the second conical tip 34 of the second support post 30 enters the U-groove depression 24, and the hemispherical tip 38 of the third support post 36 contacts the  
20 bottom side 20 of the sample 12. The three support posts as shown in Figs. 2 and 3 thus support the sample 12. The first conical tip 32 of the first support post 28 engages the side wall 40 of the cylindrical depression 22 at its lower edge 54, as shown in Fig. 2. Referring to Fig. 5, the contact of the first conical tip 32 with the

first support post 28 therefore establishes the location of one point 58 on the sample

12. The second conical tip 34 of the second support post 30 engages the long side walls 46 of the U-groove depression 24 at their lower edges 60. The contact of the

second conical tip 34 with the second support post 30 therefore establishes the

5 location of a line 62 through the sample 12. The hemispherical tip 38 of the third support post 36 then engages the bottom side 20 of the sample 12 thereby defining a plane 64 through the sample, as shown in Fig. 3. By establishing the point 58 on the sample 12, the line 62 through the point 58, and the plane 64 through the sample 12, all points on the sample 12 are in locations uniquely defined by the sample 12 and

10 sample holder 14. The sample 12 and sample holder 14 thereby create an economical system for precise position registration that is advantageous for sequential processing or examination steps, such as manufacturing a component or treating a component.

17) With reference to Fig. 2, it should be noted that the sample 12 rests on the

15 sample holder 14 at edges 54 and 60, which bear against the outer surfaces 50 and 52 of the conical tips 32 and 34, respectively. As shown in Fig. 2, there is an offset 66 between the conical tips 32, 34 and the respective inner surfaces 42, 48 of the cylindrical depression 22 and the U-groove depression 24. This offset 66 ensures that one side of the sample 12 is balanced on the outer surfaces 50, 52 of the conical tips  
20 and not on the conical tips 32, 34 themselves.

18) There are many manufacturing procedures in which several processes are performed in succession on one spot. A typical example would be in the processing of integrated circuits or other sensitive electronic components. During these

operations the work piece typically must be held in a vacuum to prevent contamination. The sample and sample holder of the present invention can therefore be used to provide a rapid means of precisely aligning the work piece.

19) An additional advantage of the system for precise position registration is that critical tolerances are not necessary for the machining of the sample and sample holder. Highly precise locations of the support posts 28, 30, and 36, the cylindrical depression 22, and the U-groove depression 24 are not required to make the location of a particular sample holder uniquely defined.

20) The sample 12 and sample holder 14 are preferably constructed of a hard material such as rigid plastic or a metal. The only requirement to achieve good alignment between the sample 12 and sample holder 14 is that the contact surfaces, such as the first 32 and second 34 conical tips, the hemispherical tip 38, the lower edge 54 of the side wall 40 of the cylindrical depression 22, and the lower edge 60 of the long side walls 46 of the U-groove depression 24 be smooth so that the sample 12 can fully seat on the support posts 28, 30, 36 without being impeded by surface roughness. Also, the materials of the sample 12 and sample holder 14 must be such that the coefficient of friction between them does not prevent the sample 12 from fully seating on the sample holder 14.

21) One obvious advantage of the precise position registration system is its mechanical simplicity. The absence of tight machining tolerances enables the system to be economically produced.

22) The sample and sample holder can be produced in a variety of sizes depending on the particular application. The sample holder can therefore be



**produced for relatively small samples, with the support posts located a few millimeters apart, or for relatively large samples in which the support posts may be located several feet across.**

**23) As the invention has been described, it will be apparent to those skilled in the art that the same may be varied in many ways without departing from the spirit and scope of the invention. Any and all such modifications are intended to be included within the scope of the appended claims.**